CLAIMS

1. A method of signal processing with reduced combinatorial complexity for evolving phenomena associated with obtainable parameters, the method including the steps of:

a) selecting from the phenomena a current phenomenon which is previously unprocessed by the method of the invention; and

b) obtaining a parameter set associated with the current phenomenon;

characterised in that the method also includes the steps of:

c) designating a start node as a parent node;

d) if there is a previously processed phenomenon with at least one existing node not yet treated as the parent node, treating the one such existing node as the parent node instead of the start node;

e) selecting a parameter from the parameter set;

f) producing a child node identity associated with the selected parameter;

g) representing child nodes of like identity for the selected phenomenon as a single node with multiple parameter relationships corresponding to parameters associated with at least one parent node;

h) representing child nodes with differing identities as separate nodes;

i) iterating e) to h) for other parameters in the set if available;

j) if there remain one or more existing nodes not yet treated as the parent node iterating d) to i) until none such remain;

k) iterating a) to j) for other phenomena in the set; and

l) deriving updated sets of parameter weights associated with respective phenomena by iterating over node relationships and identities.

2. A method according to Claim 1 characterised in that the step of deriving updated sets of parameter weights for phenomena comprises the steps of calculating for each phenomenon:

a) forward weights for the phenomenon's child nodes by summing forward weights for respective parent, grandparent *etc.* nodes (where available) weighted by associated phenomenon/parameter weights;

b) backward weights for the phenomenon's child nodes by summing forward weights for respective child of child, grandchild of child *etc.* nodes (where available) weighted by associated phenomenon/parameter weights;

c) a respective through node weight for each parameter relationship of each of the phenomenon's child nodes by multiplying its backward weight by a parameter weight obtained prior to updating and also by a summation of forward weights of the child node's parent nodes associated with that relationship; and

d) for each parameter associated with the phenomenon, a sum of the through node weights of the phenomenon's child nodes for the corresponding parameter relationship.

3. A method according to Claim 2 characterised in that it includes the step of normalising the parameter weights for each phenomenon by dividing each of them by their sum over all parameters associated with the phenomenon.

4. A method according to Claim 1 characterised in that the step of producing a child node identity expresses the identity in terms of:

a) either parameters unavailable for use in connection with subsequently generated child node identities, or

b) parameters remaining available for such use.

5. A method according to Claim 4 characterised in that the step of producing a child node identity is implemented by calculating an intersection of parameters assignable to subsequent phenomena (if unused) with a union of an identity of a parent node of a child node of the current phenomenon and a parameter expressing a relationship being implemented between the parent and child nodes in this iteration: i.e. representing set intersection and union operations by $\cap$ and U, then for a current phenomenon T_j, parameter m_k, accumulated measurements acc(j) and parent node identity I_P, the child identity I_{Ch} is given by: $I_{Ch} = acc(j) \cap (I_P U m_k)$.

6. A method of signal processing with reduced combinatorial complexity to determine trajectories for evolving physical phenomena associated with measurable parameters, the method including the steps of:

a) selecting from the phenomena a current phenomenon which is previously unprocessed by the method of the invention; and

b) measuring a parameter set associated with the current phenomenon;

characterised in that the method also includes the steps of:

c) designating a start node as a parent node;

d) if there is a previously processed phenomenon with at least one existing node not yet treated as the parent node, treating the one such existing node as the parent node instead of the start node;

e) selecting a parameter from the parameter set ;

f) producing a child node identity associated with the selected parameter;

g) representing child nodes of like identity for the selected phenomenon as a single node with multiple parameter relationships corresponding to parameters associated with at least one parent node;

h) representing child nodes with differing identities as separate nodes;

i) iterating e) to h) for other parameters in the set if available;

j) if there remain one or more existing nodes not yet treated as the parent node iterating d) to i) until none such remain;

k) iterating a) to j) for other phenomena in the set;

l) deriving updated sets of parameter weights associated with respective phenomena by iterating over node relationships and identities; and

m) determining respective trajectories for the phenomena from the updated sets of parameter weights.

7. A method of signal processing with reduced combinatorial complexity to determine trajectories for evolving physical phenomena associated with obtainable parameters, the method including

a) associating child node identities with the parameters,

b) treating child nodes of like identity for a phenomenon as a single node with multiple parameter relationships corresponding to parameters associated with at least one parent node; and

c) representing child nodes with differing identities as separate nodes.

8. A method of tracking targets by radar to measure range and bearing parameters and determine associated evolving target tracks, the method including

a) measuring range and bearing parameters;

b) associating child node identities with the parameters,

c) treating child nodes of like identity for a target track as a single node with multiple parameter relationships corresponding to parameters associated with at least one parent node;

d) representing child nodes with differing identities as separate nodes;

e) determining updated probability association weights and associated measured parameter assignments for the relationships; and

f) modifying tracks to reflect the updated probability association weights and associated measured parameter assignments.

9. Apparatus for signal processing with reduced combinatorial complexity for evolving phenomena comprising means for obtaining parameters associated with the evolving phenomena and computer apparatus programmed to:

a) select from the phenomena a current phenomenon which is previously unprocessed by the apparatus of the invention; and

b) obtain a parameter set associated with the current phenomenon;

characterised in that the computer apparatus is also programmed to:

c) designate a start node as a parent node;

d) if there is a previously processed phenomenon with at least one existing node not yet treated as the parent node, treat one such existing node as the parent node instead of the start node;

e) select a parameter from the parameter set ;

f) produce a child node identity associated with the selected parameter;

g) represent child nodes of like identity for the selected phenomenon as a single node with multiple parameter relationships corresponding to parameters associated with at least one parent node;

h) represent child nodes with differing identities as separate nodes;

i) iterate e) to h) for other parameters in the set;

j) if there remain one or more existing nodes not yet treated as the parent node iterate d) to i) until none such remain;

k) iterate a) to j) for other phenomena in the set; and

l) derive updated sets of parameter weights associated with respective phenomena by iterating over node relationships and identities.

10. Apparatus according to Claim 9 characterised in that the computer apparatus is programmed to derive updated sets of parameter weights by calculating for each phenomenon:

a) forward weights for the phenomenon's child nodes by summing forward weights for respective parent, grandparent *etc.* nodes (where available) weighted by associated phenomenon/parameter weights;

b) backward weights for the phenomenon's child nodes by summing forward weights for respective child of child, grandchild of child *etc.* nodes (where available) weighted by associated phenomenon/parameter weights;

c) a respective through node weight for each parameter relationship of each of the phenomenon's child nodes by multiplying its backward weight by a parameter weight obtained prior to updating and also by a summation of forward weights of the child node's parent nodes associated with that relationship; and

d) for each parameter associated with the phenomenon, a sum of the through node weights of the phenomenon's child nodes for the corresponding parameter relationship.

11. Apparatus according to Claim 10 characterised in that the computer apparatus is programmed to normalise the parameter weights for each phenomenon by dividing each of them by their sum over all parameters associated with the phenomenon.

12. Apparatus according to Claim 9 characterised in that the computer apparatus is programmed to produce a child node identity expressed in terms of:

a) either parameters unavailable for use in connection with subsequently generated child node identities, or

b) parameters remaining available for such use.

13. Apparatus according to Claim 12 characterised in that the computer apparatus is programmed to produced a child node identity by calculating an intersection of parameters assignable (if unused) to subsequent phenomena with a union of an identity of a parent node of a child node of the current phenomenon and a parameter expressing a relationship being implemented between the parent and child nodes in this iteration: i.e. representing set intersection and union operations by $\cap$ and U, then for a current phenomenon T_j, parameter m_k, accumulated measurements acc(j) and parent node identity I_p, the child identity I_{Ch} is given by: $I_{Ch} = acc(j) \cap (I_p U m_k)$.

14. Apparatus for signal processing with reduced combinatorial complexity for determining trajectories for evolving physical phenomena comprising means for obtaining parameters associated with the evolving phenomena and computer apparatus programmed to execute the steps of:

a) selecting from the phenomena a current phenomenon which is previously unprocessed by the apparatus of the invention; and

b) measuring a parameter set associated with the current phenomenon;

characterised in that the computer apparatus is also programmed to execute the steps of:

c) designating a start node as a parent node;

d) if there is a previously processed phenomenon with at least one existing node not yet treated as the parent node, treating the one such existing node as the parent node instead of the start node;

e) selecting a parameter from the parameter set ;

f) producing a child node identity associated with the selected parameter;

g) representing child nodes of like identity for the selected phenomenon as a single node with multiple parameter relationships corresponding to parameters associated with at least one parent node;

h) representing child nodes with differing identities as separate nodes;

i) iterating e) to h) for other parameters in the set if available;

j) if there remain one or more existing nodes not yet treated as the parent node iterating d) to i) until none such remain;

k) iterating a) to j) for other phenomena in the set;

l) deriving updated sets of parameter weights associated with respective phenomena by iterating over node relationships and identities; and

m) determining respective trajectories for the phenomena from the updated sets of parameter weights.

15. Apparatus for signal processing with reduced combinatorial complexity to determine trajectories for evolving physical phenomena comprising means for obtaining parameters associated with the evolving phenomena and computer apparatus programmed execute the steps of:

a) associating child node identities with the parameters,

b) treating child nodes of like identity for a phenomenon as a single node with multiple parameter relationships corresponding to parameters associated with at least one parent node; and

c) representing child nodes with differing identities as separate nodes.

16. Apparatus for tracking targets including radar apparatus for measuring range and bearing parameters and computer apparatus programmed to determine associated evolving target tracks by executing the steps of

a) associating child node identities with range and bearing parameters measured by the radar apparatus,

b) treating child nodes of like identity for a target track as a single node with multiple parameter relationships corresponding to parameters associated with at least one parent node;

c) representing child nodes with differing identities as separate nodes;

d) determining updated probability association weights and associated measured parameter assignments for the relationships; and

e) modifying tracks to reflect the updated probability association weights and associated measured parameter assignments.

17. Computer software for use in signal processing with reduced combinatorial complexity for evolving phenomena associated with obtainable parameters, the computer software incorporating instructions for controlling computer apparatus to execute the steps of:

a) selecting from the phenomena a current phenomenon which is previously unprocessed using the software of the invention; and

b) obtaining a parameter set associated with the current phenomenon;

characterised in that the software also incorporates instructions for controlling computer apparatus to execute the steps of:

c) designating a start node as a parent node;

d) if there is a previously processed phenomenon with at least one existing node not yet treated as the parent node, treating the one such existing node as the parent node instead of the start node;

e) selecting a parameter from the parameter set;

f) producing a child node identity associated with the selected parameter;

g) representing child nodes of like identity for the selected phenomenon as a single node with multiple parameter relationships corresponding to parameters associated with at least one parent node;

h) representing child nodes with differing identities as separate nodes;

i) i) iterating e) to h) for other parameters in the set if available ;

j) if there remain one or more existing nodes not yet treated as the parent node iterating d) to i) until none such remain;

k) iterating a) to j) for other phenomena in the set; and

l) deriving updated sets of parameter weights associated with respective phenomena by iterating over node relationships and identities.

18. Computer software according to Claim 17 characterised in that it incorporates instructions for controlling computer apparatus to derive updated sets of parameter weights for phenomena by calculating for each phenomenon:

a) forward weights for the phenomenon's child nodes by summing forward weights for respective parent, grandparent *etc.* nodes (where available) weighted by associated phenomenon/parameter weights;

b) backward weights for the phenomenon's child nodes by summing forward weights for respective child of child, grandchild of child *etc.* nodes (where available) weighted by associated phenomenon/parameter weights;

c) a respective through node weight for each parameter relationship of each of the phenomenon's child nodes by multiplying its backward weight by a parameter weight obtained prior to updating and also by a summation of forward weights of the child node's parent nodes associated with that relationship; and

d) for each parameter associated with the phenomenon, a sum of the through node weights of the phenomenon's child nodes for the corresponding parameter relationship.

19. Computer software according to Claim 18 characterised in that it incorporates instructions for controlling computer apparatus to execute the step of normalising the parameter weights for each phenomenon by dividing each of them by their sum over all parameters associated with the phenomenon.

20. Computer software according to Claim 16 characterised in that it incorporates instructions for controlling computer apparatus to produce a child node identity expressed in terms of:

a) either parameters unavailable for use in connection with subsequently generated child node identities, or

b) parameters remaining available for such use.

21. Computer software according to Claim 20 characterised in that it incorporates instructions for controlling computer apparatus to execute the step of producing a child node identity by calculating an intersection of parameters assignable to subsequent phenomena (if unused) with a union of an identity of a parent node of a child node of the current phenomenon and a parameter expressing a relationship being implemented between the parent and child nodes in this iteration: i.e. representing set intersection and union operations by $\cap$ and U, then for a current phenomenon T_j, parameter m_k, accumulated measurements acc(j) and parent node identity I_P, the child identity I_{Ch} is given by: $I_{Ch} = acc(j) \cap (I_P U m_k)$.

22. Computer software for use in signal processing with reduced combinatorial complexity for evolving phenomena associated with obtainable parameters, the software incorporating instructions for controlling computer apparatus to execute the steps of:

a) selecting from the phenomena a current phenomenon which is previously unprocessed by the software of the invention; and

b) obtaining a parameter set associated with the current phenomenon;

characterised in that the software also incorporates instructions for:

c) designating a start node as a parent node;

d) if there is a previously processed phenomenon with at least one existing node not yet treated as the parent node, treating the one such existing node as the parent node instead of the start node;

e) selecting a parameter from the parameter set ;

f) producing a child node identity associated with the selected parameter;

g) representing child nodes of like identity for the selected phenomenon as a single node with multiple parameter relationships corresponding to parameters associated with at least one parent node;

h) representing child nodes with differing identities as separate nodes;

i) iterating e) to h) for other parameters in the set if available;

j) if there remain one or more existing nodes not yet treated as the parent node iterating d) to i) until none such remain;

k) iterating a) to j) for other phenomena in the set;

l) deriving updated sets of parameter weights associated with respective phenomena by iterating over node relationships and identities; and

m) determining respective trajectories for the phenomena from the updated sets of parameter weights.

23. Computer software for use in signal processing with reduced combinatorial complexity to determine trajectories for evolving physical phenomena associated with obtainable parameters, characterised in that the computer software incorporates instructions for controlling computer apparatus to execute the steps of:

a) associating child node identities with the parameters,

b) treating child nodes of like identity for a phenomenon as a single node with multiple parameter relationships corresponding to parameters associated with at least one parent node; and

c) representing child nodes with differing identities as separate nodes.

24. Computer software for use in tracking targets by radar to measure range and bearing parameters and determine associated evolving target tracks, characterised in that the computer software incorporates instructions for controlling computer apparatus to execute the steps of:

a) associating child node identities with range and bearing parameters measured by radar;

b) treating child nodes of like identity for a target track as a single node with multiple parameter relationships corresponding to parameters associated with at least one parent node;

c) representing child nodes with differing identities as separate nodes;

d) determining updated probability association weights and associated measured parameter assignments for the relationships; and

e) modifying tracks to reflect the updated probability association weights and associated measured parameter assignments.